ERP Systems and Managerial Decision Making - A Model for Analysis

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Abstract

Implementing Enterprise Resource Planning (ERP) systems, the most significant IT development in recent times, affects all aspects of organizational life. While the positive impact of ERP systems on operational efficiencies is well established in the literature, the relationship between ERP systems, decision support capability and decision-making processes has been inadequately investigated in the past. This paper hypothesizes a research model for further investigation. Using standardization and integration, the two key characteristics of ERP systems, the influence of ERP-enabled information environment is explained in terms of its impact on the accessibility/availability, quality and quantity of information. The extent of integration and standardization achieved while implementing the ERP system and organizational culture and size are moderating variables that are expected to moderate the influence of ERP-enabled environment on managerial decision making. Extending recent studies, this study postulates a positive influence of ERP-enabled information environment on decision support capability particularly at operational and tactical level. Though improvement in the quality of information, centralization and the consequent increase in visibility and accessibility have influenced the decision support capability of managers, factors such as information overload and inadequate reporting tools in the ERP software appear to be limiting the managerial decision making capability and quality of decision making.

Keywords: ERP systems, decision making, integration, standardization

1. Introduction

Since the early days of data processing, designers of information systems have been striving to satisfy the requirements of both operational and managerial users. Much debate has centered on the ability of integrated information systems, also called as ES (enterprise systems), to satisfy both the operational requirements for managing basic resources and the managerial requirements for planning and control of these activities. In view of the standardization and integration of the processes and the centralization of responsibility in decision-making consequent to the implementation of these enterprise systems (ES), it is necessary to understand the longer-term effects of ERP systems on managerial decision-making. Even though characteristics of ERP systems such as integration and standardization of information and processes have implications for organizational decision support, this is not explicitly recognized as a major reason for implementing ERP systems.

As an ERP implementation team configures the processes and decision models in the organization, several changes could be perceived, including those relating to the roles and responsibilities of the functional or process managers, the decision-making processes in the organization, and the decisions themselves. These changes may result in a perceived as well as a real loss of autonomy and control, and the imposition of additional constraints to the process and decisions. This study, using a case study methodology, investigated the impact of ERP systems on managerial decision-making capability. In particular, it investigated the role of increased availability, visibility and use of information consequent to the implementation of ERP systems on managerial decision making capability. The paper first provides a review of the literature on ERP systems in the context of managerial decision-making and analyses the limited decision support capability of ERP systems. It then briefly explains the methodology employed in the study and follows this with the findings of the study.

2. ERP Systems – Background and Past Research

ERP systems assist management in all aspects of business transactions, from human resources to production, maintenance, purchasing, sales and distribution, and customer service. These packaged software solutions are configurable information systems that integrate information and information-based processes within and across functional areas in an organization [25]. Considering their standardized and automated processes and their transactional focus, they are also described as systems that show users how to process business transactions and offer a management control system to facilitate planning and communication for managers [6]. ERP systems thus provide

solutions to 'operational' integration problems as well as meeting the 'informational' requirements of managers [48, 33]. They are therefore expected to reduce costs by improving efficiencies through integration, standardization and automation, and to enhance decision-making by providing accurate, real-time, relevant, up-to-date and timely enterprise-wide information [8, 30]. This section reviews the past research on ERP systems in general and analyzes the limited decision support capability of ERP systems

Early studies on ERP systems predominately focused on issues such as how these systems added organizational value [26, 8, 31, 43]; implementation issues and methodologies [36, 40, 2, 22]; key factors for successful adoption, and potential problems that may arise during ERP implementations such as end user acceptance and participation [27, 24]; software and organizational fit [41]; and measuring ES success [37]. As can be seen, most of the initial research on ES focused predominantly on issues relating to the implementation phase [13]. Even though organizations achieved some operational, managerial or IT infrastructure benefits after implementing ERP systems [44, 39, 9], their impact on decision-makng had not yet been adequately analyzed [6, 20]. Given the increasing presence of ERPs in a large number of organizations today, it is important to investigate their impact on organizations and particularly on organizational decision-making in different cultural contexts [20, 21].

Because of their transaction-centric nature, the capability of ERP systems to support managerial decision-making is considered limited [4,5]. Even though increased transaction processing efficiencies, higher quality information, greater accessibility of information, and greater support for ad hoc reporting were identified as some of the benefits of implementing ERPs [15, 17], very little impact on the business analysis and decision support areas of management accounting was noticed in the past research. In particular, the use of ERP systems appears to have had only a minor effect on the use of newer management accounting practices, such as Activity Based Costing [ABC] systems, Balanced Scorecard [BSC], value-chain analysis, etc., that emphasize sophisticated manipulation of information rather than simply extracting and reporting transactional data [17, 5]. These authors concluded that ERP systems have simply enhanced mass processing of documents, with very limited true decision support capability. A study by Booth and others in Australia also reported that ERP systems perform better in transaction processing and ad hoc decision support than in sophisticated decision support and reporting [4]. Given the complexity of ERP systems and their conceptually different nature from most stand-alone legacy systems, it is not surprising that ERP users take some time to learn how to extract all potential benefits [10, 39].

Reporting tools available in ERP systems were generally considered inadequate for decision-making by many adopters. Though ERP systems have the capability to generate standard reports that can generally meet average decision-making concerns, many firms feel the need for non-standard reports [17]. Recognising this inherent weakness, a majority of large organizations have invested significant effort in redesigning the reporting tools to suit their internal decision-making styles and processes, though this is relatively expensive and difficult, especially when it involves the transfer of information from legacy systems [14]. Adam and Doyle noted that the reporting capabilities of the ERP packages available in the market were not sufficient for organizations despite vendors' claims that the software includes leading-edge reporting capabilities [1].

In fact, lack of flexibility of reporting tools and excessive time and costs for training staff for amending existing reports and/or developing new reports were some of the reasons cited for the inability of ERP systems to support decision-marking [45]. Stanek and others noted that many of the observations made several years ago on the relationship between ERP systems and decision support systems [DSS] remain fundamentally true and are just as relevant today as they were at the time [45]. Reporting is such a unique management need that many ERP software vendors are not able to cater to the differing needs of their customers, even those in the same industry, with standard reporting tools and solutions, despite their efforts over time to produce various upgrades and versions.

It appears that several major ERP software vendors have recognized and acknowledged the weaknesses of their systems in providing decision support. In response to such criticisms, they have started offering extension products such as business intelligence warehousing and business analytics, supply chain management, customer relationship management and product life cycle management that offer decision support capability. Organizations are increasingly 'bolting-on' a decision support system from different vendors on top of the existing ERP system and deriving the benefits of increased automation of processes and powerful decision support capability. For example, SAP, even in their 'mySAP ERP' all-in-one solution, have incorporated new reporting functionality in the form of 'Business Analytics' to their new customers in the mid-market. This new generation of software, developed recently by ERP vendors, is designed to sit on top of the ERP system to provide a more value-adding and strategic information analysis

capability. These developments explicitly signal that ERP systems by themselves have limited capacities to meet such needs, and software vendors are offering additional tools and solutions to support decision-making capability. As noted by Holsapple & Sena, the increase in such third party offerings and extensions to ERP systems by the major software vendors reflects the weakness of ERP systems in delivering decision support benefits to business organizations [21].

3. Research Model

In an ERP environment, decision making is expected to be more information-based. Even though ERP systems are not designed primarily to provide decision support and intelligent capability like any other decision support system, the information-based environment facilitated by ERP systems are expected to have implications for the quality, quantity, accessibility/availability and visibility of information. Improved access to relevant, accurate and up-to-date information enables managers to make better decisions and may potentially contribute to competitive advantage [11]. In fact, improved decision making was one of the key reasons sited by managers for implementing ERP systems [12]. As noted by Davenport and others, "driven by the desire for accurate, consistent, complete, real-time information, executives are seeking the same type of efficient, transparent and 'frictionless' real-time decision making capability that many manufacturers achieved with just-in-time manufacturing," [11, pp.21]. In a recent survey, 59% of organizations reported decision making as a distinctive capability delivered by ERP implementation [19]. Similarly, accurate, relevant, real-time, current and single-point view of information enabled by the ERP system is expected to improve both the decision making process as well as its quality. Increased volume of information enabled by the ERP systems, may provide managers information that was hitherto scattered in different places and hidden in various independent information silos, and may contribute to improvement in the decision making process. There, however, is a risk of information overload as a result of availability of increased volume of information facilitated by an ERP system and may hamper the quality of decision making. A research model is thus hypothesized and explained below.
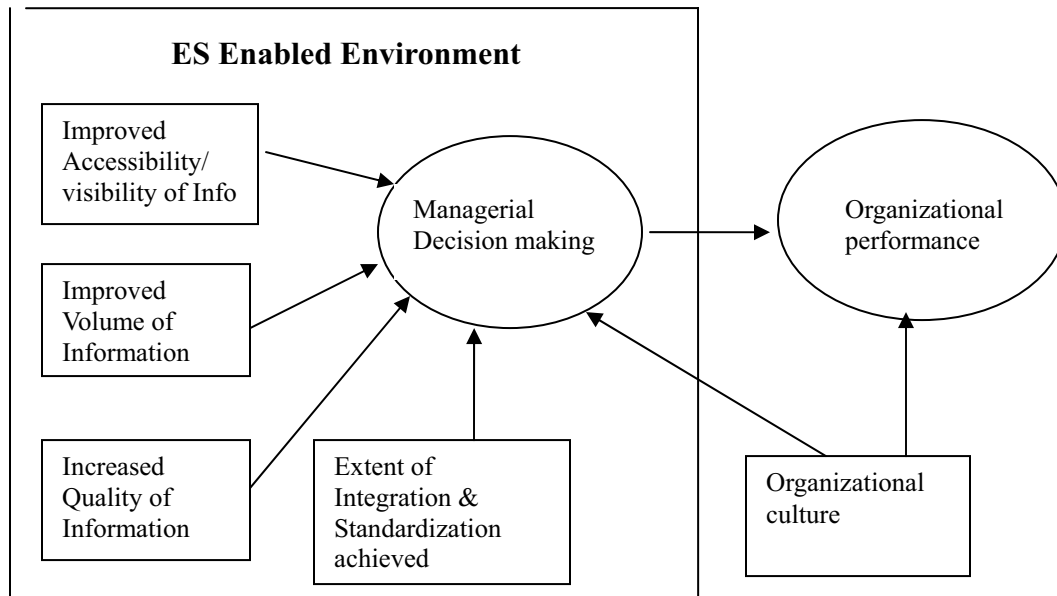

Figure 1: Research Model – ERP systems and managerial decision making

3.1 Characteristics of ES-environment

Integration and standardization, the two key characteristics of ERP systems, could be used to explain the benefits of implementing ERP systems in organizations [39, 9]. Integration of business processes and information results in providing management with better information for decision making and can speed up overall flow of information and transactions [32]. Standardization, defining exactly how a process will be executed consistently anywhere in the enterprise or by anybody, delivers efficiency and predictability [10, 32]. Integration in ERP systems context is viewed from three perspectives – vertical integration, horizontal integration and technical integration While the horizontal

integration is a critical determinant for facilitating cooperation and managing interdependencies across business functions [8], vertical integration facilitates enhanced visibility, accessibility, management control and decision support capability [26]. Horizontal integration enables a 'single version of the truth' across the organization and ensures end-to-end visibility, accuracy and certainty of the information that will eventually lead to improved decision making and organizational performance [3, 10, 26].

Vertical integration, however, may facilitate better understanding of the processes and information, centralization of management control, and single real-time view of information and thereby may contribute to improvements in managerial decision making [8, 21]. Thus an ERP-enabled environment characterized by integration and standardization, may enhance visibility, availability, quantity and quality of information and thereby lead to improved decision making capability. It is however, important to note the limitations and costs associated with these two characteristics. Inadequate levels of standardization may limit a firm's ability to access information and use it for decision making even if data is available somewhere in the system. Absence of right, consistent, accurate and relevant information, may limit organization's ability to make effective decisions as well as the efficiency of decision making processes. Therefore, higher the level of standardization achieved, higher the capability of the firm to take advantage of the ES-enabled environment in decision making. The full benefits of standardization will, however be felt more if the organization is global and if the processes are repetitive and transaction-based processes such as 'procure-to-pay' and 'order-to-cash'. Thus, organizational size and nature also influences the ERP-enabled environment and thereby the managerial decision making.

3.2 Accessibility, Visibility & Availability of information

Integration of information and processes across an enterprise is expected to increase the accessibility and visibility of information to various functional and operating staff and to assist them in their activities. Considering that ERP systems are a mechanism of integration that allows automation of routine and predictable activities and transactions, they are expected to enhance the visibility of information across the organization without the much needed communication and/or interaction. Thus, ERP system facilitates integration of processes and information horizontally across various units and functions, as well as vertical integration between different hierarchical levels in the organization. This horizontal integration of information and business processes, enhances the instantaneous access to the real-time up-to-date information unlike in an disintegrated environment where the information has to flow through formal channels of communication. Similarly, the vertical integration facilitated by the ERP system also enhances the visibility and accessibility of information to the management without asking for information. In an unintegrated environment, information typically be summarized and massaged by the lower levels of management before submitted as an input for tactical and strategic decision making by senior management.

On the technical side, the integration of information systems and databases facilitates enhanced knowledge processing and improves the information processing capability and thereby the reliability and speed of decisions [Holsaple and Sena 2005]. Increased information visibility is expected to encourage managers to base their decisions on real-time information and facts rather than on rumors or subjective opinions and/or summarized information presented by the lower level managers. Since the information in an ERP environment is instantaneously visible to all employees and managers at multiple levels, it gives no scope or time for manipulation of the information or a smoothing of its effects. Thus, it will have a positive influence on the decision making processes as well as on the decision making capability in the organization.

This influence on decision making capability and effectiveness, however, is expected to be moderated by the extent of implementation of ERP systems and/or the extent of integration achieved. Since most of the claimed benefits of ERP systems over legacy systems and best-of-breed systems arise from the integration of information and processes across functional areas, the ability to extract benefits will be reduced if only a limited set of ERP modules are implemented and/or only a limited inter-connectivity is allowed between various hierarchical levels. Evidence from the field suggests that the so-called integration is not full and complete even in organizations where full implementation has reportedly taken place [9]. In certain organizations where only two or three modules are implemented, the level of integration, and therefore the extent of the visibility and accessibility of the information across the organization, is limited. If information and process integration is not achieved both in terms of the quality and depth, then all the potential benefits of ERP systems should not be expected, including that of improved managerial decision-making capability and effectiveness. Thus, the improved visibility/availability and accessibilty of information enabled by ERP system may positively influence the managerial decision making process and decision making capability of the firm. It,

however, will be constrained by the extent of integration and standardization achieved while implementing ERP system and the organizational culture, a moderating variable in this study.

3.3 Volume of Information

In providing transactional data, ERP systems tend to increase the volume of information available to managers. While this may reduce the responsibility of decision-making at the operating level, it may actually increase the volume of information required to be handled by management. ERP systems, while providing good transactional engines for operational control, tend to increase the volume of information available to managers [6]. This may contribute to information overload as well as an increase in the complexity of managerial decision-making. According to Eppler and Mengis, research on information overload in the realm of management has mainly been undertaken in the areas of accounting, management information systems [MIS], organization science and marketing [12]. The question of how the performance [in terms of adequate decision-making] of an individual varies with the amount of information the individual is exposed to, is an important issue to be investigated. Even though the amount of information one receives influences positively the quality of decisions or reasoning in general, researchers found that this is true only up to a certain point [12]. If further information is provided beyond this point, the performance of the individual will rapidly decline [7]. This is because the information provided beyond this point will no longer be integrated into the decision-making process, resulting in information overload [34]. The burden of a heavy information load will confuse the individual, affect their ability to set priorities, or make prior information harder to recall [12, 34].

By contrast, Eppler and Mengis further contend that a similar way of assessing the information overload phenomenon consists of comparing the individual's information processing capacity [the quantity of information one can integrate into the decision-making process within a specific time period] with the information processing requirements [i.e. the amount of information one has to integrate in order to complete a task [12]. The requirements refer to a given amount of information that has to be processed within a certain time period. If the capacity of an individual only allows a smaller amount of information to be processed in the available time slot, then information overload is the consequence. Schick and others also stressed time as the most important factor regarding the information overload problem [34]. Interesting within this discussion is Schroder and others suggests that information load and processing capacity are not independent of one another, but that the first can influence the second, i.e. dealing with a rather high information load increases one's processing capacity up to a certain point [35]. In addition, feelings of stress, confusion, pressure, anxiety or low motivation that may be potentially caused by the introduction of any new information system/IT enabled innovation, and particularly a complex ERP system, may signal information overload [18].

It is not only the amount of information and the available processing time [i.e. the quantitative dimension], but also the characteristics of information [i.e. the qualitative dimension] that are seen as major overload elements [23]. In addition, some of the qualitative characteristics of information such as novelty, intensity, uncertainty, complexity and ambiguity can either contribute to overload or reduce it [23]. This leads us to examine the quality of information generated by ERP systems. Thus, though information overload is a complex issue influenced by the characteristics of information, processing capability of the individual manager and information processing requirements, the literature suggests that information overload caused by ERP systems beyond a certain point may be counter-productive. While increasing the complexity of the decision-making process, it may actually contribute to selective use of information by managers in order to deal with the uncertainty and complexity of the real world. Therefore increase in the volume of information enabled by the implementation of ERP system may have no positive effect on the managerial decision making capability and process. It, however, may be moderated by the extent of the implementation characterized by the level of integration and standardization achieved. If the firm has achieved higher level of integration and standardization, then the increased volume of information facilitated by the ERP system may positively influence the decision making process.

3.4 Quality of Information

Quality of information is expected to influence managerial decision processes and their outcomes. ERP systems, while disciplining the basic information transactions for efficiency and standardization across the enterprise, empower all levels of employee on information analysis issues and provide flexibility [42, 38]. In an ES environment, it becomes necessary for everyone in the organization to understand not only the process in which they work, but also their own specific task, along with the impact their work has on other aspects of the business. This involves a culture shift and forces some discipline in the data entry and information management fields. In addition, the integration of information and processes, standardization of the information/data and processes, elimination of data redundancy enabled by the

implementation of ERP systems contributes to consistency and accuracy of the information [44]. This ensures that the same data is used throughout the enterprise for better and consistent planning and control through single view of information across the enterprise. Therefore, the quality of information provided for decision making is better in an ERP enabled environment.

The skills of employees, which vary from one organization to another, however, may not guarantee input of consistent quality data and may affect the quality of information. The integration of the data across various functions will enhance the critical requirement of the data quality and, unlike in independent legacy systems, may not give opportunities for operating personnel to correct those data quality issues immediately [38]. The risk of incorrect data entry is also relatively high in an ERP context as a data element is entered only once. Thus, ERP systems, while reducing the costs of data entry and improving the overall quality of information, may pose a significant control risk for day-to-day management. In addition, the ability of ERP systems to push data gathering activity to the point of its origination may have a further effect on the quality of information. Operating personnel such as loading workers, production operators and maintenance personnel may not be motivated to carry out data entry and may have neither the skills to input the data nor the ability to understand its implications [47]. While some features of ERP systems such as validity rules for data entry, restrictions on type of data, display of possible entries and match code selections could minimize the possibility of errors, its implementation is still considered a challenge [47, 44].

Even if the information in the ERP system is accessible across the organization in a standard format, the information contained within an ERP system may itself be incomplete. ERP system cannot provide all the information necessary for decision support. There is a wealth of information outside the ERP systems environment that is at least as crucial and important for decision-making as that available in the ERP systems [46]. Other sources of information such as published statistics, market data, industry reports/news items, experts' opinions etc., though typically outside the traditional ERP boundaries, may provide invaluable support for decision-making. Similarly, legacy systems may contain years of historical data that can be crucial in determining the trends and patterns that could offer intelligent decision support [6]. Even though many organizations have implemented ERP systems, some legacy systems have been left in tact for economic and/or managerial reasons and the historical data contained in them could not be fully transferred into the new ERP system for several organizational reasons [38]. Therefore, it is debatable that ERP systems provide all the information necessary for managerial decision support. ERP system may discourage managers to look beyond ERP system for information and thus may limit the decision making quality and capability of the managers.

Therefore, the skills of employees, the data quality and information management discipline of lack of it, incomplete information available from ERP system are characteristics of organizational and managerial culture that are specific to an organization. Therefore, while the improved quality of information enabled by ERP-enabled environment may have a positive influence on the managerial decision making process, it, however, is expected to be limited by the organizational culture, a moderating variable in this study.

3.5 Organizational factors – culture and size

The extent of the influence of ERP-enabled environment on the quality, accessibility, availability and usage is dependent upon other factors such as the extent of standardization and integration achieved consequent to the implementation as well as organizational size and culture. In addition, managerial decision processes depend largely on the individual decision-maker, the organization in which the decision-maker operates, and the quality of information provided. Thus, organizational culture influences managerial decision making processes as well as its capability. In fact, the flow of information (both volume and quality) within organizations instructs, informs and supports decision-making processes and the decision-maker, and can also act as a constraint on both [29]. According to Gendron and others, several researchers in the past have proposed a number of approaches to understanding, assessing and improving information quality [16]. Information quality relates not only to the intrinsic quality of information but also to how the information will be used by stakeholders for various purposes and in different contexts. An improvement in the quality of decision support and the decision-making process is expected with the improved quality and quantity of information and data consistency facilitated by ERP systems.

Even if an ERP system provides information necessary for decision support, its selective use by managers in a organizational context influenced by organizational culture is an issue. Selective use of information in managerial decision-making, irrespective of its availability and accessibility, is a typical managerial trait, particularly under

conditions of uncertainty. Managers use information selectively in order to rationalize their decision processes and prefer to use data and decision-making processes "with which they are comfortable" [28]. Although ERP systems make information available for managerial decision-making, the application of such information is dependent upon individual managerial preferences and conditions. The choice for using the information is, however, limited by the extent of automation in the decision-making process. In implementing an ERP system that results in standardization and integration of information and processes, and by configuring the processes, organizations in a way, are eliminating some routine decisions normally made by process users [6, 38].

ERP systems are integrated mechanisms that would increase information processing capability at both the individual and organizational level by automating routine and predictable tasks. For example, by setting up certain limits to credits, triggers for stock reorders, availability checks and other order conditions in sales order processing, organizations are eliminating the need for managerial approval, thereby reducing operational decision-making to a mechanistic level. Strategic and tactical level decision making, however, is still in the hands of senior management and are dependent upon the consolidated information available in an ERP system.

By deliberately suppressing genuine choices about some matters and treating them mechanistically, ERP systems will reduce the decision making at the operational level. The choices inherent in the configuration of the ERP systems eliminate the choices to be made by users, thereby reducing the responsibility of employees to make certain routine decisions. These conditions configured in the ERP system will improve the efficiency of the processes and ensure consistent execution of the decisions. The danger in such automated decision-making, however, is that it may lead to inattention to the opportunities of improving the process over time. Consequently, managers may learn to accept consequences without questioning them, allowing the decision-making model to mask reality, with assumed uncertainties embedded in the system.

4. Conclusions

ERP systems will continue to be consequential phenomena for years to come and nearly affect all aspects of organizational life throughout their operational lives. Standardization and integration, the key characteristics of ERP systems enabled information environment, facilitates increased quantity and quality of information and improved accessibility and availability of information to managers for decision making. Access to single-view of information across the enterprise that is real-time, accurate and relevant, puts pressure on managers to use that information intelligently and efficiently, and improve their decision making, and, thereby the overall organizational performance. This involves a culture shift for managers in posting, storing, accessing, and using the information and its single-view across organization, and applies pressure for improved performance. The influence of these characteristics on the managerial decision making capability, however, are influenced by the extent of integration and standardization achieved while implementing ERP systems and the organizational factors such a size and culture. It is necessary to study further the interactions of these various complex variables in a range of organizational contexts that occur following the implementation of ES and to explore the differences and common patterns which occur. Such understanding will assist managers in better management of processes as well as outcomes, and lead to full exploitation of the huge investments made on IT-enabled innovations.

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